wind. At 9 a. m. the agents telephoned to the station that the sulphur vapors were apparently as thick in the holds as ever, that they had planned to begin loading at 8 a. m., and consequently desired assistance. A man with the aerothrust fan was sent to the ship and in three hours the vessel was clear of fumes. Had the fan been used as soon as the holds were opened loading would have been possible at 8 o'clock as planned. On the other hand if the machine from the station had not been available, loading would undoubtedly have been delayed until the following morning, entailing on the owners a loss of several hundred dollars.

Several times it has been demonstrated that a hold full of sulphur fumes could be cleared in 30 to 40 minutes when other holds, not blown out, were after the same interval apparently as full of the gas as when first opened. On a warm dry day with a good breeze, artificial ventilation is of doubtful advantage after either cyanide or sulphur fumigation, but if any of these conditions are lacking artificial ventilation will save time for all hands. At Boston quarantine the machine is used as a routine after cyanide fumigation regardless of weather conditions, and our experience allows us to recommend the same procedure for other stations. In addition, it is believed that each steamship company whose vessels require fumigation should have at least one horizontal machine for use after sulphur fumigation, as it will save time for their vessels and pay for itself many times over.

Conclusions.

Quarantine stations at which HCN fumigation is practiced should be equipped with mechanical means for artificial ventilation.

The gasoline driven fan as adapted for this use is satisfactory for the prompt ventilation of compartments of vessels after fumigation.

For the expeditious handling of large vessels three machines are recommended, two of the horizontal pattern (downward thrust) and one of the vertical pattern (horizontal thrust).

THE LIGHTING OF INDUSTRIAL ESTABLISHMENTS.

THE NEED FOR SUPERVISION, WITH A SUGGESTED SYSTEM OF MAINTENANCE RATING FOR ARTIFICIAL LIGHT EQUIPMENT.

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The importance of an adequate, hygienic, and well-distributed system of artificial illumination in industrial establishments is well understood. After such systems have been installed, however, the part played in the upkeep of the illuminating system in maintaining its efficiency at the original level is often slighted. The lack of proper maintenance may reduce the amount of available light by as

much as 50 per cent. At the present time, when the industrial world is being mobilized, the adequate maintenance of systems of artificial lighting becomes doubly important in view of the increasing necessity for night work and the favorable effect of abundant light upon production.

It is clear, therefore, that not only must the physical lighting equipment of industrial establishments be considered, but attention must be paid also to its maintenance. The importance of adequate upkeep for artificial light equipment may not at first sight appeal to the user. A consideration of the points involved, however, will indicate that if such work is neglected excessive losses of otherwise useful light are bound to result.

The following system of maintenance rating for artificial lighting equipment has been devised by the writer. It is thought that it should prove of distinct utility in enabling manufacturers to keep their lighting systems efficient.

Carbon, metalized, and tungsten filament, mercury vapor, arc, and open-flame and mantle lamps become inefficient, due to the following causes:

1. Continued use.
2. Dirt and dust accumulations on lamps and reflectors.
3. Burn outs and breaks.
4. Reflectors becoming cracked, broken, or missing.
5. Mechanical injury to connections.

Various other items of deterioration take place so gradually that in many cases they are given no special attention in the practical economy of the shop.

1. *Continued use.*—The life of a lamp is not, as generally supposed, the elapsed time between entering into service and when it burns out. The life of a lamp as given by its manufacturers is its economic life. Thus when a lamp burns a certain number of hours it may be shown that its energy consumption per light unit has increased to such a degree that it is economy to replace it with a new one.

2. *Dirt and dust accumulations on lamps and reflectors.*—It has been shown by actual measurement that the loss of light due to absorption by dust and dirt for average conditions is about 50 per cent for equipment that has not been cleaned for four months; also that a small quantity of dust, so small as to be hardly noticeable, will cut down the light by 20 per cent.

3. *Burn outs and breaks.*—It is evident that a burn out or break may cut down the light by 100 per cent. Often, however, a burn out or break may be of such a nature that the light source does not fail entirely, but that the light is greatly diminished.

4. *Reflectors cracked, broken, or missing.*—The addition of a reflector to a lamp generally adds about 50 per cent to the light delivered

in useful directions. When a reflector is cracked or broken the light from the unit is diminished according to the nature and extent of the damage to the reflector.

5. *Mechanical injury to connections.*—The loss of light due to mechanical injury to the connections will vary with the nature of the injury. Often the injury is of such a nature as to cause a flickering or intermittent light. It may cause a total failure of the light or it may be a source of danger to the workman due to electric shock.

Lighting installations are designed to give desirable initial intensities of illumination at the work and it is assumed that the equipment will be so maintained as to produce this intensity. From cost considerations the initial intensity is made as low as possible for work to be done efficiently, and for prevention of eye strain and accidents. It is readily seen that when deterioration of the lighting equipment sets in, the intensity of illumination falls off and if this deterioration is not arrested, serious efficiency losses follow. Often lighting systems are allowed to deteriorate to an extreme point and nothing is done unless complaints come in from employees after the lighting facilities throughout the shop have become so poor that work has to be temporarily discontinued. The production loss from such circumstances when added up throughout the year greatly exceeds the expense of systematic attention to maintenance in advance.

In making illumination surveys of shops it was found desirable to note how well the lighting equipment was maintained and to arrive at an approximate figure, by inspection, that would denote the degree of maintenance. The term efficiency of maintenance is used to designate the percentage of the initial intensity that a lighting equipment will give, the loss in intensity being due to the lack of proper maintenance.

The following table shows the method adopted of rating artificial lighting equipment. The efficiency of maintenance in each case represents approximately the percentage of light given by the equipment after the loss of light due to the corresponding condition is deducted.

Condition.	Efficiency of maintenance.
	Per cent.
Lamp dirty	80
Lamp very dirty	70
Lamp blackened due to aging	80
Lamp too large or small for reflector	80
Lamp missing, broken, or filament shortened	50
Reflector dirty	80
Reflector very dirty	70
Reflector cracked	80
Reflector broken or missing	50
Connections loose or drop cord bare	80

There follows an example taken from one department of a shop recently inspected.

GENERAL OVERHEAD UNITS. SHOP NO. 3.04, TOOL ROOM.

12 units, lamps dirty, reflectors dirty.
3 units, lamps dirty, reflectors missing.
2 units, lamps dirty, reflectors very dirty.
9 units, lamps very dirty, reflectors very dirty.
1 unit, lamps very dirty, reflectors missing.
1 unit, lamps dirty, reflectors clean.
2 units, lamps dirty, reflectors dirty, lamps blackened.

To arrive at the efficiency of maintenance for shop No. 3.04 tool room, it is necessary to multiply the number of units having a given condition by the values of the efficiency of maintenance for those conditions and take a mean.

12 x 0.80 x 0.80	7.68
3 x .80 x .50	1.20
2 x .80 x .70	1.12
9 x .70 x .70	4.40
1 x .70 x .50	.35
1 x .80	.80
2 x .80 x .80 x 0.80	1.02
30	16.57

$$\frac{16.57 \times 100}{30} = 55.2 \text{ per cent efficiency of maintenance.}$$

By measurement with an illuminometer the average illumination was increased by 100 per cent by bringing the efficiency of maintenance up to 100 per cent.

A department of maintenance of artificial lighting equipment should be inaugurated in every factory and workshop. This maintenance work should be made a part of the electrical department, which is in the best position to make periodic inspections of lighting equipment. Reports of inspections, using a system as outlined above, should be made to the factory manager and efficiencies of maintenance of 100 per cent maintained. The ratings given above are liberal and an efficiency of maintenance of 100 per cent is not unreasonable.

By adopting such a practice a large economic waste could be avoided and losses due to decreased production, inferior products, accidents, and defective eyesight minimized.